Urinary incontinence 4 and 12 years after first delivery: Risk factors associated with prevalence, incidence, remission, and persistence in a cohort of 236 women.

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Title

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Abstract:

Aims: Our aim was to study risk factors associated with prevalence, incidence and remission of UI 4 and 12 years after first delivery

Methods: 774 nulliparous women who gave birth in 1996 in two French maternity units at term received a questionnaire about their urinary symptoms in 2000 and again in 2008. 236 women returned a questionnaire about UI 4 and 12 years after first delivery. Four groups of women were built: A) women continent 4 and 12 years after first delivery; B) women continent at 4 and incontinent at 12 years; C) women incontinent at 4 and continent at 12 years; and D) women incontinent at 4 and 12 years. Multivariate logistic regressions were used to determine risk factors of UI prevalence (groups B+D vs. A+C), incidence (B vs. A), remission (C vs. D) and onset of UI (D vs. B).

Results: Factors associated with UI 12 years after first pregnancy were: BMI (OR = 1.17 [95%CI: 1.04-1.32], by 1 kg/m2) and increasing BMI (1.43 [1.19-1.73]), first child's weight (1.08 [1.001-1.16], by 100 g) and UI during first pregnancy (3.77 [1.83-7.76]). Factors associated with UI incidence were age at first delivery (0.86 [0.75-0.98]) and high BMI (1.24 [1.05-1.45]). Increasing BMI, UI during first pregnancy, and heavy first child reduce the likelihood of UI remission (0.37 [0.20-0.68], 0.11 [0.02-0.63], and 0.73[0.59-0.91] respectively).

Conclusions: UI during first pregnancy could be indicative of individual susceptibility to UI. Obesity appears to be a modifiable factor for remission of UI in women.

Keywords: Urinary incontinence, mode of delivery, parity, body mass index, age

Introduction

Various risk factors such as age, obesity, pregnancy and mode of delivery have been associated with an increased risk of urinary incontinence (UI) in women. Numerous epidemiological studies are in favour of a causal link between vaginal delivery and UI.[1-5] These observations are supported by studies showing that vaginal delivery can cause injuries to the levator ani or the pudendal nerves.[6,7] For DeLancey, deterioration of the continence mechanisms depends on ageing and the severity of obstetric events, particularly the first delivery that may lead to various types of irreversible damage.[8] The role of menopause and hormone replacement therapy (HRT) in tissue ageing are currently controversial.[9] Concerning pregnancy-related incontinence, how and when obstetric and metabolic risk factors may promote UI is not clearly established.[10] Viktrup et al., who reported prevalence of UI during pregnancy and after first delivery,[11] found a maximal prevalence just before delivery with a sudden drop and progressive remission twelve months after first delivery.[2] This may suggest that we have to consider UI as a dynamic process which may sometimes begin before first delivery and disappear during the year following delivery. Later, UI may reoccur in some women with ageing or weight gain. Our group suggests that the trauma effect of first delivery may progressively disappear with ageing while other factors possibly linked with pregnancy such as weight gain could explain the link between pregnancy and late onset UI.[10]

Our objective was to analyse prevalence, incidence, remission of UI, and late or early UI onset between 4 and 12 years after the first delivery in a cohort of 236 women.

Methods

We conducted a follow-up of women included in a previous comparative study, the main objective of which was to compare pelvic floor disorders 4 years after first delivery in two hospitals with different policies for episiotomy.[3,12] This study included nulliparous women who gave birth in 1996 at a term of 37–41 weeks to a live-born singleton with a cephalic presentation. The cohort was based on extraction from the obstetrics database of the two hospitals. The patients received a postal questionnaire in 2000, 4 years after first delivery (baseline). If no response was received, a second and then a third letter were sent. They were asked in this questionnaire if they agreed to participate in a new enquiry. If the response was "Yes", they received a second questionnaire in 2008, 12 years after first delivery (follow-up) (Figure 1).

Data about the mothers (age at first delivery, height and weight), pregnancy and delivery (epidural, mode of delivery, duration of the active-pushing second stage of labour, child's weight) were collected at delivery. Information about pelvic floor disorders, weight, new pregnancies and deliveries were obtained from the mailed questionnaires. A question about urinary incontinence during the first pregnancy was included in the 4-year questionnaire. Height and weight were obtained to determine body mass index (BMI) in 2000 and 2008 for each patient. The BMI-variation variable allowed us to study the variations of patients' BMI during follow-up. In 2008, questions were asked about parity twelve years after first delivery and the mode of delivery. The "additional parity" variable during follow-up was defined as the number of subsequent pregnancies between 2000 and 2008 to study more specifically the influence of pregnancy on later UI. We also selected the "first child's weight" variable which can be linked with the trauma theory. The responses to the "mode of delivery" question could be 'vaginally every time' or 'always by caesarean section' or 'at least once vaginally and at least once by caesarean section'.

The question of interest 4 and 12 years after first delivery was 'Do you have involuntary loss of urine?'. If the women answered 'yes' to this question, they were considered to have urinary incontinence. The Sandvik score was used to estimate UI severity. This score combines frequency and amount of leakage and it showed good correlation with pad-weighing tests.[13]

For the analysis we distinguished four groups of women based on UI at base-line (4 years after first delivery) and UI at follow-up (12 years after first delivery): i) women continent at base line and follow-up (n=125, group A, *Stay continent*); ii) women continent at baseline and incontinent at follow-up (n=32, group B, *Become incontinent*); iii) women incontinent at baseline and continent at follow-up (n=30, group C, *Become continent*); and iv) women incontinent at baseline and follow-up (n=49, group D: *Stay incontinent*) (Figure 2). In the bivariate analysis, we examined the differences between variables in the four groups of women. The Chi-square test for heterogeneity was used for categorical variables and the ANOVA test for quantitative variables. In order to check that the four groups built corresponded to described events, we built the "deltaSandvik" variable, subtracting the Sandvik score in 2008 from the Sandvik score in 2000.

Four final explanatory models were built using multiple logistic regression, and these models numbered from 1 to 4 were used for the following comparisons: 1) *Prevalence UI model* comparing incontinent women (groups B +D) with continent women (groups A+C) at follow-up; to study factors associated with UI prevalence 12 years after first delivery. 2) *Incidence UI model* comparing group B (become incontinent) with group A (stay continent). This model analyses risk factors associated with UI arising at some time after the first pregnancy. They can be associated with new pregnancies or other events such as weight gain. 3) *Remission UI model* comparing group C (become continent) with group D (stay incontinent), to pinpoint factors associated with remission of UI some time after the first pregnancy; 4) *Onset UI model* comparing group B (become incontinent) with group D (stay incontinent). This

comparison concerns the beginning of UI: women in group D were incontinent less than 4 years after first delivery while in group B UI first occurred at a later date. It investigates more specifically the supposed factors associated with the traumatic aspect of UI.

Variables were not divided into classes in order to avoid loss of power due to categorization of the variables. The linearity of our variables was verified by using likelihood ratios. The parameter values for each of the final models were estimated by the maximum likelihood method.

The factors retained for the multivariable analysis were those associated with a level of significance $p < 0.20$ during bivariate analysis and those that were clinically relevant to our hypothesis (for example mode of delivery, parity). We also included in our models the patients' age and the centre, considered as confusion factors. We planned to build each multivariate model with the same variables.

All analyses were performed with Stata 9.0 (Stata Corp., College Station, Texas).

Results

The questionnaire was mailed, 12 years after first delivery, to the 572 women who had accepted to participate in the survey. However 254 (44.4%) had moved, and didn't receive it. Of the 318 women who received the questionnaire, 236 sent their responses (74.2%) (Figure 1).

The mean age of the responders was 41.3 years (± 4.5), mean parity was 2.1 (± 0.5) and mean BMI was 22.7 kg/m^2 (±3.7). The mean age was not significatively different between women who stayed I-para and women who had 1 or more supplementary pregnancies. Responders were significantly older at first delivery (29.3 versus 27.8 years, p=0.03) and had a higher educational level (72.7 versus 64.4% had high school diploma, p=0.001) than the non-responders (defined as all women who didn't answer). Differences between responders and non-responders for obstetrical variables, centre, or body mass index (BMI) were not significant (data not shown). The prevalence of UI was similar at baseline and follow-up (4 and 12 years after first delivery), respectively 33.5 and 34.3% (p=0.23, Figure 2). The mean Sandvik score was also similar at baseline and follow-up (0.8±1.4 versus 0.9±1.8, p=0.23). The *de novo* UI rate was 20.4% during follow-up and the UI remission rate was 38.0% (Figure 2). Between baseline and follow-up the continence status had changed for 62 women (26%). No women reported UI surgery during the interval.

The mean difference in UI severity score (deltaSandvik) was zero in group A (stay continent during the period), was greater than 1 in group B (become incontinent) and negative in group C (become continent) with a significant difference between the four groups (Table I).

The women's characteristics according to continence status at baseline and follow-up are presented in Table II. The prevalence of UI at follow-up increased with a higher weight for the first child, a higher BMI at baseline, and increased BMI at follow-up (Model 1, Table III). Incident UI during follow-up was associated with a younger age and a higher BMI at baseline

(Model 2, Table III). A BMI increase, UI during first pregnancy, and a heavy first child reduce the likelihood of UI remission (0.37 [0.20-0.68], 0.11 [0.02-0.63], and 0.73 [0.59-0.91] respectively) (Model 3, Table III). An early UI onset (vs. later) was associated with UI during the first pregnancy, and increased BMI at follow-up (Model 4, Table III). No association was found between additional parity and UI in any model.

Discussion:

Our study showed that despite similar prevalence rates 4 and 12 years after first delivery, UI is a dynamic condition with various situations and different risk factors: an older age was associated with a higher risk of developing UI 12 years after first delivery in women continent at 4 years; UI during the first pregnancy increased the long-term risk of UI and decreased the chance of remission between 4 and 12 years; a higher weight of the child was associated with a higher risk of UI 12 years after first delivery and decreased the chance of remission; a high BMI at baseline was associated with a higher risk of developing UI 12 years after first delivery, while loss of weight increased the chance of remission.

The strength of this study resides in its longitudinal design and the long follow-up period. Most epidemiological studies analysing UI are cross-sectional.[1,14-16,19,20] They consist in interviewing women of different ages at the same point in time. This element is of major importance in the examination of obstetric risk factors because obstetrical practices have considerably changed over the last 30 years. Specifically, women are not equally exposed to caesarean section now as compared to 30 years ago. In France, the c-section rate rose from 11% in 1981 to 16% in 1995, and 21% in 2010.[15,16] Cross-sectional studies compare women exposed to different prevalences for c-section, which may explain why, in the EPINCONT study, women delivered by c-section were younger than women delivered vaginally.[14]

Four studies[2,4,17,18] have reported on UI more than 10 years after the first delivery. Unlike in our study, their analysis addressed UI prevalence: this type of analysis does not allow factors which may modulate the risk of UI after delivery to be taken into account, in particular modifiable factors or factors posterior to delivery.

However, the small size of our sample limits the power of the study and the number of variables which could be used in multivariate analyses. The lack of association between mode of delivery and incontinence could be explained by our small sample size. In addition the fact

194 that UI during the first pregnancy was assessed 4 years after delivery rather than during or
195 immediately after delivery is also a limitation of our study. We had a high rate of non-
196 response twelve years after the first delivery, mostly because the women had moved. We
197 assume that that moving was not associated with UI. Older women and women with a higher
198 educational level had higher response rates at baseline and follow-up. These differences might
199 affect symptom prevalence, but not changes (incidence or remission) between baseline and
200 follow-up. Using self-administered questionnaires introduces an element of subjectivity. This
201 element of subjectivity is admitted by the ICS definition of UI "complaint of involuntary
202 loss"[19] and the use of a validated questionnaire and the Sandvik score allowed us to test the
203 reality of our question of interest.

204 Obesity and overweight are risk factors for an increased risk of UI found in numerous cross-
205 sectional epidemiological studies.[20-22] We found that higher BMI 4 years after first delivery
206 and an increase of the BMI between 4 and 12 years were associated with a significant increase
207 of the risk of long-term UI. The incidence of *de novo* UI was associated with a higher BMI
208 while remission of UI was associated with a decrease in BMI. This last result is in agreement
209 with the recent randomised trial by Subak et al. on 338 overweight and obese incontinent
210 women. They showed that a programme of moderate weight loss allowed the frequency of the
211 episodes of incontinence to be reduced by about 50 %.[23]
212 Despite the fact that the mode of delivery in our study was not associated with incidence or
213 remission of IU, it is interesting to note that other obstetric variables (first child's weight, UI
214 during first pregnancy) do seem to be associated with UI remission. Negative outcomes
215 related to obstetrical factors are always difficult to interpret and events occuring during a
216 subsequent pregnancy and delivery may influence later continence status.

217 Pregnancy could reveal an individual susceptibility for later UI through cervico-urethral
218 mobility. We know that there is a link between prenatal urethral mobility and postnatal SUI[24]

but there is still no data in the literature about the link between cervico-urethral mobility and UI during first pregnancy.

The first child's weight was already known to be a risk factor for UI after the first delivery.[17,18] In our study, an increase of 100 g in the first child's weight increased the risk of long-term incontinence by 8.0 %, independently of the mother's BMI and mode of delivery, and decreased the chances of remission. This factor was possibly associated with the mode of delivery and the consequences in terms of trauma. But the association between the first child's weight and risk of UI can also be explained by metabolic causes, e.g. gestational diabetes mellitus (GDM). We know that GDM favours foetal macrosomia and is a risk factor for later type 2 diabetes and SUI.[25,26]

Another point to discuss is the inverse relation between *de novo* UI and age at first delivery: the older the women were at the time of their first delivery, the lower the risk of developing *de novo* UI. Our hypothesis is that older continent primiparous women are a selected healthy population: if they are still continent despite ageing and a first delivery, they are protected against *de novo* UI later.

As we specified above, the "onset of UI" model, which compares early versus later UI, investigates more specifically the supposed risk factors associated with the first delivery. The risk of early UI is considerably increased in women whose UI started before the first delivery compared with the women whose UI began later; this suggests the importance of constitutional factors in UI. BMI was also associated with an earlier onset of UI but we were not able to explain our results.

Conclusion

The presence of UI during first pregnancy could be indicative of an individual susceptibility to UI. Obesity appears to be a modifiable factor for remission of UI in women. It seems essential to consider these constitutional factors (UI during the first pregnancy) and weight gain as being just as important as the mode of delivery when studying female UI.

Tables and figures

Table I : Mean deltaSandvik according to the four groups of patients.

Table II : Distribution of risk factors according to continence status 4-12 years after first delivery.

Table III : Risk factors for UI prevalence 12 years after first delivery, incidence, remission and persistence of UI between 4 and 12 years after first delivery.

Figure 1 : Flowchart.

Figure 2 : Continence status 4-12 years after first delivery.

Contribution to authorship

ACP contributed to analysis and interpretation of data and article writing. XF contributed to the conception of the study, the design and the interpretation of data and article writing. KM contributed to data management, AF contributed to analysis and interpretation of data and revision of the article and EQ to data interpretation and revision of the manuscript. JPS contributed to conception of the initial study.

Disclosure of interests

We have no direct or indirect commercial financial incentive associated with publication of the article.

Ethical approval

Our work complies with French statutes and regulations, which authorize epidemiological surveys without advance approval of an ethics committee. Our survey involved no intervention and is thus excluded from the French statute on biomedical research (LoiHuriet-Serusclat, dated 20 December 1998). We complied with all French statutes concerning data

about the subjects, confidentiality, and restrictions (e.g. no religious or racial data). Informed consent was obtained from each responding woman. The Ethical Review Committee « Comité d'éthique de la recherché en obstétrique et gynécologie » of the French college of Gynaecologists and Obstetricians has examined the research and found it to comply with generally accepted scientific principles and medical research ethical standards (CEROG-2009-022).

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Table I.

Evolution of the urinary incontinence severity score (deltaSandvik) between baseline and follow-up according to the four groups of women.

Group A) women who were continent at baseline and follow-up; B) women continent at baseline who became incontinent at follow-up; C) women incontinent at baseline who became continent at follow-up; and D) women incontinent at baseline and follow-up.

	Evolution of the UI severity score				
Groups	Stay continent	Become incontinent	Become continent	Stay incontinent	
	Group A	Group B	Group C	Group D	
	(n=125)	(n=32)	(n=30)	(n=49)	
	mean (±SD)	mean (±SD)	mean (±SD)	mean (±SD)	p
deltaSandvik*	0 (±0.0)	+2.0 (±1.6)	-2.1 (±1.4)	+0.6 (±2.0)	$<10^{-4}$

*deltaSandvik = variable subtracting the Sandvik score in 2008 by the Sandvik score in 2000.

Table II.

Distribution of risk factors according to continence status 4-12 years after 1st delivery. Group A) women who were continent 4-12 years after 1st delivery; B) women who were continent 4 years after 1st delivery and 12 years after; C) women who were incontinent 4 years after 1st delivery and became continent 12 years after, and D) women incontinent 4-12 years after 1st delivery.

Three bivariate logistic regressions were performed between groups A versus B, C vs. D, and B vs. D. Significant results ($p < 0.20$) are indicated by the index letter of the group concerned by the comparison.

		Continence status 4 and 12 years after first delivery			
Risk Factors	n (%) or mean (±SD)	Stay continent Group A (N=125)	Become incontinent Group B (N=32)	Become continent Group C (N=30)	Stay incontinent Group D (N=49)
Menopausal	No	118 (94.4)	31 (96.9)	29 (96.7)	46 (93.9)
	Yes	7 (5.6)	1 (3.1)	1 (3.3)	3 (6.1)
High school diploma	No	34 (27.4)	7 (21.9)	10 (34.5)	13 (26.5)
	Yes	90 (72.6)	25 (78.1)	19 (65.5)	36 (73.5)
Regular physical activity	<1/week	70 (56.0)	21 (65.6)	18 (60.0)	32 (65.3)
	≥ 1/week	55 (44.0)	11 (34.4)	12 (40.0)	17 (34.7)
Age at 1st delivery	(years)	29.0 (±4.4)	28.3 (±3.7)	30.3 (±4.7)	30.1 (±4.8)
UI* during 1st pregnancy	No	106 (86.9)	25 (80.7)	20 (69.0)	21 (43.7)
	Yes	16 (13.1)^{D}	6 (19.3)	9 (31.0)	27 (56.3)^{A}
Gestational age at 1st delivery	< 40 weeks	61 (48.8)	16 (50.0)	14 (46.7)	19 (38.8)
	≥ 40 weeks	64 (51.2)	16 (50.0)	16 (53.3)	30 (61.2)
Mode of 1st delivery	vaginal	115 (92.0)	29 (90.7)	29 (96.7)	45 (91.8)
	cesarean	10 (8.0)	3 (9.4)	1 (3.3)	4 (8.2)
First child's weight	(/100g)	32.4 (±4.4)^{D}	32.9 (±4.4)	31.7 (±3.4)^{D}	33.9 (±4.0)^{A,C}
BMI at baseline‡	(kg/m^2)	21.3 (±2.7)^{B,D}	22.8 (±4.1)^{A}	22.5 (±3.7)	23.0 (±3.9)^{A}
Delta BMI during follow-up‡‡	(kg/m^2)	0.7 (±1.6)^{D}	1.1 (±2.1)	-0.2 (±2.4)^{D}	1.7 (±2.0)^{A,C}
Parity at baseline†	1	53 (42.4)	11 (34.4)	13 (43.3)	22 (44.9)
	2+	72 (57.6)	21 (65.6)	17 (56.7)	27 (55.1)
Additional parity during follow-up††	0	28 (22.4)	5 (15.6)	8 (26.7)	14 (28.6)
	1	60 (48.0)	16 (50.0)	16 (53.3)	24 (49.0)
	2+	37 (29.6)	11 (34.4)	6 (20.0)	11 (22.4)
Mode of all deliveries	Only vaginal	107 (85.6)	29 (90.6)	28 (93.3)	45 (91.8)
	Only cesarean	9 (7.2)	0	0	3 (6.1)
	Mixed	9 (7.2)	3 (9.4)	2 (6.7)	1 (2.1)

*UI: Urinary incontinence.

‡BMI at baseline: Body Mass Index in 2000 (four years after first delivery). ‡‡Delta BMI during follow-up: variation of Body Mass Index between 2000 and 2008 (between four and twelve years after first delivery).

†Parity at baseline: parity four years after first delivery. ††Additional parity during follow-up: number of subsequent pregnancies between 2000 and 2008 (between four and twelve years after first delivery).

Table III.

Risk factors for UI prevalence 12 years after first delivery, incidence, remission, and persistence of UI between 4 and 12 years after first delivery. Variables included in each multivariate model were those associated with p <0.20 during bivariate analysis (BMI at baseline, delta BMI during follow-up,UI during first pregnancy, first child's weight) and those originally planned (maternity, age, mode of delivery). Non significant variables (p>0.20) during bivariate analysis (menopausal status, high scool diploma, regular physical exercise, smoking) were not included.

Group A) women who were continent at baseline and follow-up; B) women continent at baseline who became incontinent at follow-up; C) women incontinent at baseline who became continent at follow-up; and D) women incontinent at baseline and follow-up.

Risk factors for UI prevalence 12 years after 1st delivery, incidence, remission, and persistence of UI between 4 and 12 years after 1st delivery

		Model 1: UI prevalence at follow-up UI vs. no UI (B+D vs. A+C)	Model 2: Incidence of UI at follow-up in women continent at baseline (B vs. A)	Model 3: UI remission at follow-up in women incontinent at baseline (C vs. D)	Model 4: Onset of UI in women incontinent at follow-up early vs. later (D vs. B)
Risk factors		adjusted OR [95% CI]			
Age at 1st delivery (years)		0.97 [0.89-1.05]	0.86 [0.75-0.98]	0.96 [0.82-1.13]	1.26 [1.05-1.50]
UI* during 1st pregnancy	No	1	1	1	1
	Yes	3.77 [1.83-7.76]	1.72 [0.54-4.49]	0.11 [0.02-0.63]	7.33 [2.06-26.04]
BMI at baseline (kg/m2) ‡		1.17 [1.04-1.32]	1.24 [1.05-1.45]	0.97 [0.76-1.25]	0.88 [0.74-1.06]
Delta BMI during follow up‡‡		1.43 [1.19-1.73]	1.17 [0.93-1.47]	0.37 [0.20-0.68]	1.46 [1.03-2.08]
First child's weight (/100g)		1.08 [1.001-1.16]	0.99 [0.89-1.10]	0.73 [0.59-0.91]	1.24 [1.03-1.48]
Parity at baseline†	1	1	1	1	1
	2+	1.03 [0.54-1.98]	1.63 [0.62-4.25]	0.95 [0.25-3.55]	0.75 [0.21-2.65]
Additional parity during follow up††	No	1	1	1	1
	Yes	1.03 [0.51-2.07]	1.01 [0.40-2.52]	0.33 [0.07-1.51]	1.10 [0.31-3.93]
Mode of 1st delivery	Vaginal	1	1	1	1
	Caesarean	0.51 [0.14-1.90]	0.78 [0.15-4.19]	0.34 [0.01-11.69]	0.15 [0.02-1.45]

*UI: Urinary incontinence.

‡BMI at baseline: Body Mass Index in 2000 (four years after first delivery). ‡‡Delta BMI during follow-up: variation of Body Mass Index between 2000 and 2008 (between four and twelve years after first delivery).

†Parity at baseline: parity four years after first delivery . ††Additional parity during follow-up: number of subsequent pregnancies between 2000 and 2008 (between four and twelve years after first delivery).

Figure 1: flowchart

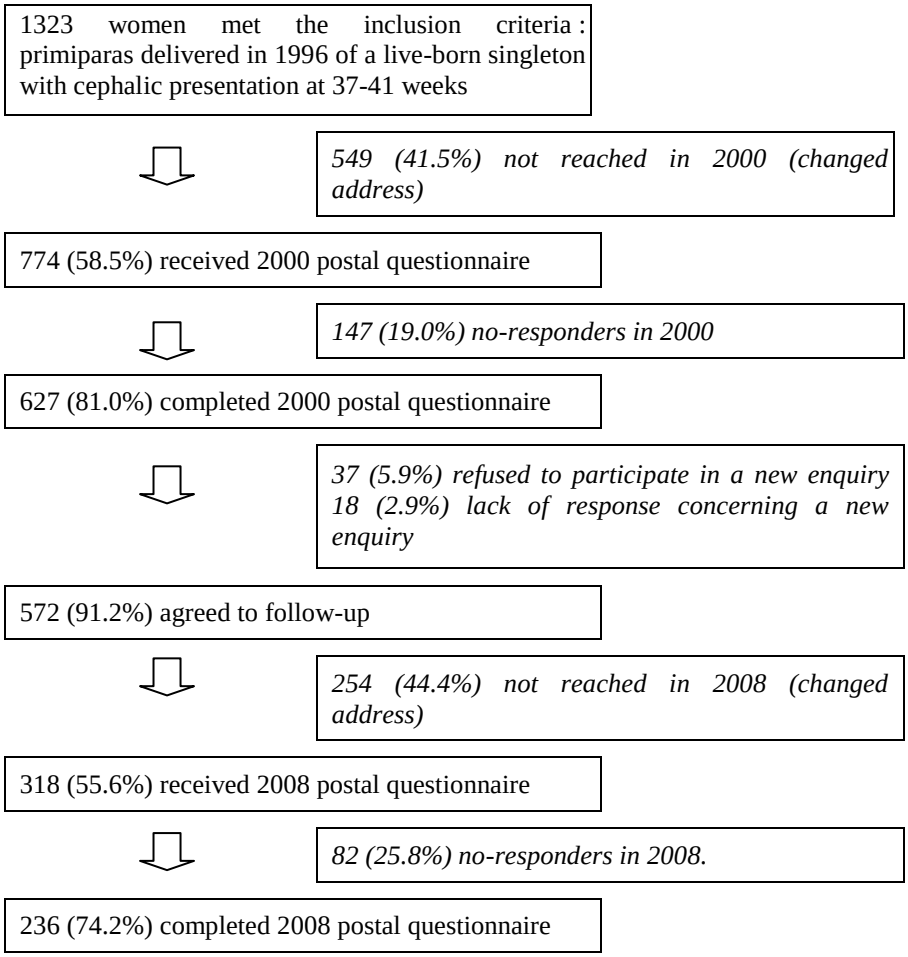

Figure 2.

Continence status 4-12 years after 1st delivery: Group A) women who were continent at baseline (in 2000) and follow-up (in 2008); B) women continent at baseline who became incontinent at follow-up; C) women incontinent at baseline who became continent at follow-up; and D) women incontinent at baseline and follow-up.